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Boucher, Steve; Guirkinger, Catherine

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Risk, Wealth and Sectoral Choice in Rural Credit Markets

Steve Boucher* and Catherine Guirkinger

Department of Agricultural and Resource Economics

University of California, Davis

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*Corresponding author.
Agricultural and Applied Economics
University of California – Davis
One Shields Avenue
Davis, CA 95616

Phone: 530-752-1527
Fax: 530-752-1517
Email: boucher@primal.ucdavis.edu

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In developing countries, informal and formal credit sectors coexist in spite of large interest rate differentials. This coexistence is troubling given the recent wave of financial liberalization aimed at broadening and deepening formal credit markets. Two main explanations are offered in the literature. First, the informal sector may be the recipient of "spillover" demand from the formal sector (Bell, Srinivasan, and Udry 1998; Conning 1996; Hoff and Stiglitz 1990). In this view, formal lenders have limited local information and must rely on collateral to solve the moral hazard and adverse selection problems inherent in credit transactions. Informal lenders' ability to substitute information-intensive screening and monitoring for collateral allows them to offer contracts to individuals that are excluded from the cheaper formal sector.

An alternative explanation is that lower transaction costs allow informal lenders to offer loans with lower effective cost (Chung 1995; Kochar 1997; Mushinski 1999). In this view, the informal sector need not be the sector of last resort but instead may be the preferred sector. This latter explanation is important because it emphasizes that multiple dimensions of loans contracts must be considered when analyzing sectoral choice.

In this paper, we expand upon this view and argue that an additional, crucial dimension of loan cost, namely risk, has been neglected. If borrowers are risk averse and insurance markets are under-developed, the relevant cost differential across sectors should be thought of in terms of expected utility instead of expected income. We argue that the lower collateral requirements of informal loans imply greater consumption smoothing for borrowers compared to the formal sector alternative.[1] If the cost of this implicit insurance, in terms of lower expected consumption, is not too high, then some borrowers may undertake expected income enhancing investments that they would forego if they only had access to a more risky formal loan. The

informal sector, by permitting a reduction in collateral, may thus relax both quantity rationing and another form of non-price rationing termed "risk rationing" by Boucher, Carter & Guirkinger (2005).

We draw on several strands of the theoretical literature on credit rationing to formalize these two potential roles of the informal sector. As in Bester (1987) and Schmidt-Mohr (1997), we acknowledge the use of collateral as a means used by lenders to address asymmetric information. The effectiveness of collateral in averting non-price rationing is limited, however, in rural areas of developing countries, where collateral assets are scarce and insurance markets are weak. The premise of our analysis is that informal lenders' better access to local information allows them to offer contracts with lower collateral. As a result, an informal loan may be demanded both by those who cannot post the collateral required by the formal sector and by those who can but are unwilling to do so because of the associated risk. As in Conning (1996), we portray the informal lender's information advantage as the ability to monitor borrowers and impose a penalty for shirking. The ensuing collateral reduction, however, comes at a cost as informal lenders expend resources on monitoring that must be recovered via a higher interest rate. We extend Conning's model, which assumes borrower risk neutrality, to allow for the more realistic assumption of risk aversion. By doing so, our analysis shows that the informal sector not only absorbs the spillover demand of the poorest agents who are excluded from the formal sector, but also may be preferred by a class of agents who could obtain a formal loan.

While it is easy to show that spillover demand derives from the poor, characterizing the location within the wealth distribution of the second group is complicated because of counter-veiling impacts of wealth under risk aversion. We derive sufficient conditions regarding agent preferences to determine the impact of agent wealth on sectoral choice.

The structure of the paper is as follows. The next section motivates the ensuing theoretical analysis by using descriptive evidence from several recent household surveys to document the multiple roles played by the informal loan sector. We then lay out a model in which agents choose both activity and loan sector. We next take up the impact of agent wealth on activity and sectoral choice. When farm size if fixed, we show that a fairly strong condition on borrower preferences is required to deliver the intuitive result that the informal sector relaxes formal sector risk rationing for agents that are relatively poor in terms of *liquid* wealth. The penultimate section extends the model to allow for heterogeneity in farm size. We show that weaker conditions on agent preferences are required for the informal sector to relax formal sector risk rationing for agents that are relatively poor in terms of *land* wealth. The final section concludes.

Descriptive evidence on the roles of the informal sector

In this section we use data from three recent farm-household surveys in Latin America to provide descriptive evidence on the relationship between formal and informal loan sectors and the multiple reasons that farm households seek informal loans.[2] We define three loan sectors. The formal sector consists of regulated financial institutions and includes commercial banks, state development banks, credit unions and, in the case of Peru, rural and municipal banks. The informal sector includes moneylenders, input supply dealers, traders, and agro-processing firms. Finally, the semi-formal sector includes unregulated lending institutions such as NGO's and government loan programs.

Table 1 compares key contract terms across the three sectors.[3] The general picture that emerges from table 1 is that in each country the formal sector offers more attractive loans

compared to the informal sector with respect to size, interest rate, and maturity.[4] The most striking difference is the case of Peru, where informal loans carry an average annual interest rate of 117%, which is nearly double the interest rate in the formal sector. The same patterns hold in Honduras and Nicaragua.

Table 2 compares participation in the various credit market sectors for households facing positive supply versus no supply. Households with positive supply either obtained a formal loan in the previous twelve months or believed they could obtain one. The dominance of contract terms in the formal sector discussed above suggests that a household would only seek an informal loan if it were denied access to the formal sector.[5] Table 2, however, suggests otherwise. For example in Peru, 28% of households that had access to a formal loan borrowed only from the informal sector, suggesting that these households preferred the informal sector despite the apparently inferior loan terms it offers. In Honduras and Nicaragua, 11% and 6% of households with positive formal supply chose to borrow exclusively from the informal sector. While these percentages are lower than in Peru, overall household participation in any sector of the credit market is also lower. In Honduras and Nicaragua respectively, informal borrowers represent 22% and 20% of households that borrowed and had a choice across sectors.

Why, then, would a borrower prefer the informal sector? A comparison of collateral requirements across the two sectors suggests an answer. A glance back at table 1 reveals that, across these three samples, at least 58% of formal loans required that the borrower post physical assets, typically agricultural land, as collateral. Informal loans, in contrast, required collateral much less frequently. Taken together, the data suggest that borrowers face a choice between lower cost but higher risk (collateral) contracts available in the formal sector versus the higher cost but lower risk contracts of the informal sector.[6]

It would seem, then, that the informal sector indeed plays multiple roles. Important fractions of households that are shut out from the formal sector resort to informal loans, suggesting that the informal sector indeed receives spillover demand from the formal sector. Yet the informal sector also appears to be the sector of choice for other households and risk considerations appear to at least partially drive this choice. In Peru, for example, 46% of households that chose the informal sector gave the risk associated with posting collateral as the primary reason for forgoing a formal loan.

Finally, table 2 also reports mean wealth levels for households in each category. Two patterns emerge. First, households shut out of the formal sector are poorer. Second, of those households with access to the formal sector, informal borrowers are poorer than formal borrowers. We now turn to constructing a conceptual framework that can help explain the patterns suggested by this descriptive analysis.

Model Setup

In this section and the next we develop a model that examines optimal loan contracts in each of two sectors and agents' choice both across sectors and alternative activities. We begin by outlining the key assumptions about preferences, technology and information and then describe the potential choices that agents may face. The model contains three types of actors: farmers, formal lenders, and informal lenders. All farmers are endowed with one unit of land and labor. Heterogeneity across farmers derives from their endowment of financial wealth, $W \in \left[\underline{W}, \overline{W}\right]$.

We posit a simple technology that allows us to explore the dual roles of credit as both provider of liquidity and, potentially, insurance. Farming requires a fixed investment, $K > \overline{W}$. In order to produce on their own land, farmers thus require outside finance. We further assume

that if a farmer borrows, the lender funds the full amount of the investment, K.[7] Farming is risky. Gross farm revenues are X_g if the state of nature is "good" and X_b if the state of nature is "bad," with $X_g > K > X_b$. Finally, the farmer's fallback, or reservation, activity is to work as a wage laborer and earn a certain wage, ω.

The farmer potentially has three choices. The first is whether to farm or work as a wage laborer. If she chooses to farm, she faces two additional choices: loan sector and effort level, e, which is committed after receiving the loan. The effort level, which we assume can be either high, H, or low, L, affects welfare and choice in two ways.[8] First, high effort increases the probability of the good state and thus raises the expected farm returns. Letting p^H and p^L denote the probabilities of the good state under high and low effort levels, this implies $p^H > p^L$. Let $\overline{X}^H$ and $\overline{X}^L$ represent expected gross revenues under high and low effort and r^F and r^I denote the opportunity cost of capital for formal and informal lenders, with $r^F < r^I$. The following inequalities summarize our assumptions regarding the impact of effort on expected returns:

(1) $$\overline{X}^H - r^I K > \omega > 0 > \overline{X}^L - r^F K.$$

The first inequality implies that, even evaluated at the informal lender's higher opportunity cost of capital, farming with high effort is more profitable than wage labor. The last inequality implies that any loan contract will require high effort. Since effort is not contractible, lenders face a moral hazard problem and must provide incentives to induce the agent to choose high effort.

While high effort increases expected farm returns, it also causes disutility. We assume the following additively separable utility function: $U(Y,e,m) = u(Y) - d(e,m)$. The first term is the utility of income, which we assume is increasing and concave. To ensure that quantity rationing may occur, we assume that when income is zero, utility is finite.[9] Income, Y, in turn is

composed of initial wealth plus the net income from the chosen activity. The second term is the disutility of effort, which depends both upon the effort level chosen by the farmer and *m*, the level of monitoring chosen by the lender as follows:

$$(2) \qquad d(e,m) = \begin{cases} \overline{d} & if \ e = H \\ \underline{d} + \beta m & if \ e = L \end{cases}$$

with $\overline{d} > \underline{d} > 0$ and $\beta \geq 0$. Like effort, monitoring is carried out after the loan is granted. If she exerts high effort, the borrower's disutility is unaffected by monitoring. In contrast, if she exerts low effort, her disutility is increasing (at the constant rate β) in the monitoring level.

Whether or not the borrower decides to shirk depends upon the private benefit of doing so. Let *B* denote the reduction in the borrower's disutility resulting from choosing low instead of high effort. From equation 2, the private benefit of shirking is: $B(m) = \alpha - \beta m$, where $\alpha = \overline{d} - \underline{d}$ is the agent's disutility differential under zero monitoring. Monitoring thus addresses the moral hazard problem by reducing the borrower's private benefit of shirking.[10] We posit that informal lenders' access to local information grants them a monitoring advantage *vis-a-vis* more centralized and socially distant formal lenders. Informal lenders are members of the local community and can thus impose a punishment, for example damaging the borrower's reputation, that formal lenders cannot. We operationalize this informational advantage by assuming $\beta > 0$ for informal lenders and $\beta = 0$ for formal lenders. Formal lenders will thus never monitor.

Formal and Informal Credit Contracts

We now turn to the agent's choice of loan sector. We treat the loan sectors as independent and allow the agent to borrow from at most one lender. Finally, we assume perfect competition and risk neutrality of lenders in each sector.

The Potential for Non-Price Rationing in the Formal Sector

We begin with the contracting problem in the formal sector. Let R_j^F be the portion of farm returns retained by the borrower in state *j* under a formal contract.[11] To find the optimal contract, we use a modified principal-agent framework in which the agent (farmer) chooses the feasible contract that maximizes her expected utility. Let $V_F(W)$ be the borrower's formal sector value function, or the expected utility from the optimal formal sector contract. The optimal formal contract is the solution to:

$$(4) \quad V_F(W) \equiv \underset{R_j^F}{Max} \quad EU(W + R_j^F, H, 0)$$

subject to :

$$(5) \quad [u(W + R_g^F) - u(W + R_b^F)](p^H - p^L) \geq B(0)$$

$$(6) \quad p^H(X_g - R_g^F) + (1 - p^H)(X_b - R_b^F) - r^F K \geq 0$$

$$(7) \quad R_j^F \geq -W; \quad for \ j = g, b$$

Equation 5 guarantees that the agent's expected utility gain from choosing high effort outweighs the private benefit of choosing low effort. Let the *incentive compatibility boundary*, *ICB(m)*, denote the locus of contracts such that this constraint binds under monitoring level *m*. Equation 6 is the *formal sector participation constraint (FPC)*, which requires that the formal lender's expected profits are non-negative. Finally, equation 7 is the *limited liability constraint (LLC)*, which states that borrowers cannot be made liable for an amount greater than their financial wealth.

The primary features of the problem and the implications of asymmetric information are illustrated in figure 1. The axes represent the contractual return to the borrower under each state. Note that, even if R_b is negative, consumption in the bad state is positive as long as $R_b > -W$. The agent's indifference curves are convex to the origin. The risk neutral lender's expected profit

contours are straight lines with slope $-\frac{1-p^H}{p^H}$. Along one of these contours the agent's expected return is also constant; however her expected utility is increasing towards the 45-degree line. The shaded area depicts the set of feasible contracts. These contracts lie below the *ICB(0)* curve, to the southwest of the formal lender's zero-profit contour, π_0^F, and above the *LLC,* which is the horizontal line at $R_b^F = -W$. Given the shape of the feasible contract set, the constrained optimal formal contract, if it exists, is unique and found at point C, the intersection of the ICB*(0)* and π_0^F curves.[12] Of all available contracts, it is the one that yields highest expected income and lowest risk.

Figure 1 also demonstrates the potential for non-price rationing in the formal credit market. In general the closer a contract is to the 45-degree line, the greater is the borrower's consumption smoothing across states. Indeed, in a first best world with costless enforcement of effort, the optimal contract would be at point A and fully insure the agent's consumption. Under asymmetric information the lender faces a trade-off in providing insurance versus providing incentives for the borrower to work hard. In figure 1, the introduction of asymmetric information effectively "removes" the contracts between points A and C from the feasible set. In order to induce the agent to work hard, the lender must reward her with a high return under the good state and punish her with a low return under the bad state. If the latter is negative, the borrower must post collateral.

This asymmetric information induced reduction of the set of available contracts can result in two types of non-price rationing. Quantity rationing occurs when an agent has a profitable project but *cannot* undertake it because the lender makes no contract available. In figure 1, the agent would be quantity rationed if the LLC was shifted up above point C. Risk rationing, in

contrast, occurs when an agent has a profitable investment project but *chooses* not to undertake it, even though she has access to a loan that would raise her expected income, because the contract forces her to bear too much risk. Figure 1 illustrates this risk rationing outcome. Point B represents the reservation activity, which pays ω in both states. Although the agent's expected return from the contract at point C is greater than ω, the contract is sufficiently risky such that its certainty equivalent, at point D, is less than ω.

Under both forms of non-price rationing, the agent ends up in the low return reservation activity. In the case of quantity rationing, she has no choice because the feasible contract set is empty. If agents were risk neutral, a non-empty feasible set would be necessary and sufficient for the agent to undertake the most profitable activity. If agents are risk-averse, access to a contract is necessary but no longer sufficient for the most profitable activity to be chosen. Identifying the impacts of asymmetric information on lenders' willingness to offer contracts is thus insufficient to understand credit market participation. A complete understanding also requires attention to the risk implied by contracts and to borrowers' willingness to accept that risk.

Characterization of the Optimal Contract in the Informal Sector

As in the case of the formal sector, we assume informal lenders are risk neutral and competitive. They differ from formal lenders in two ways. First, $r^I > r^F$, so that the informal lender's cost of funds is higher than the formal lender's. As a result, an informal loan will always be more expensive than a formal one and will yield a lower expected return to the borrower. Second, informal lenders can monitor borrowers. Like formal loans, informal loan contracts must induce high effort.

Let $V_I(W)$ be the agent's informal sector value function. In addition to specifying the borrower's return in each state, the optimal informal contract specifies a level of monitoring, *m*, and is the solution to the following problem:

$$(8) \quad V_I(W) \equiv \underset{m,R_j^I}{Max} \quad EU(W + R_j^I, H, m)$$

subject to:

$$(9) \quad [u(W + R_g^I) - u(W + R_b^I)](p^H - p^L) \geq B(m)$$

$$(10) \quad p^H(X_g - R_g^F) + (1 - p^H)(X_b - R_b^I) - r^I K \geq m$$

$$(11) \quad R_j^I \geq -W; \quad for\ j = g, b$$

Monitoring affects the feasible contract set in several ways. An increase in *m* lowers the private benefit of shirking and thus relaxes the incentive compatibility constraint (equation 9). Monitoring, however, comes at a cost. Since the lender must recover resources spent on monitoring, the lender's participation constraint (equation 10) tightens. The left-hand panel of figure 2 depicts the upward shift of the *ICB* and the downward shift of the *LPC* accompanying an increase in monitoring from *0* to *m*. The optimal contracts conditional on the lower and higher levels of monitoring are at points E and F respectively. In the right hand panel, the dashed curve traces out the *conditional contract set* (*CCS*), which is the locus of intersections between the *ICB* and the *LPC* for each level of monitoring. The optimal informal contract, point G in figure 2, is the point on the *CCS* that maximizes the borrower's expected utility.

Rethinking the role of the informal sector

An increase in monitoring makes available some new contracts that require less collateral and are thus less risky but eliminates those with highest expected returns. A necessary condition for the informal sector to relax quantity and risk rationing is that the conditional contract set includes

some contracts that require less collateral than the optimal formal contract while still offering an expected return greater than the reservation wage. We assume this holds.[13]

Figure 3 depicts the two roles of the informal sector. In the left hand panel the informal sector is the recipient of "spillover" demand from the formal sector. The agent faces quantity rationing in the formal sector since the minimum collateral required for the optimal formal contract at point H exceeds the agent's wealth. The optimal informal contract at point *J* is both feasible and preferred to the reservation activity.

The right hand panel of figure 3 depicts the case of a farmer who chooses to borrow from the informal sector even though a lower cost formal contract is available. The optimal informal contract at M requires sufficiently lower collateral (offers sufficient insurance) such that it is strictly preferred to both the formal contract at L and the reservation activity. This farmer would be risk-rationed in the formal sector since the certainty equivalent of the optimal formal contract is less than ω.

Wealth and Activity Choice

Now that we have depicted the two potential roles of the informal sector, we turn to the question: For whom does the informal sector play these roles? In other words, how do we understand the mapping of agents of different wealth across formal and informal sectors? We proceed in three steps. First we focus on supply to see who is quantity rationed in the formal sector. Second, ignoring quantity rationing, we look at the unconstrained choice across the agent's three options (wage labor, farm with formal contract, farm with informal contract). We examine the three pair-wise comparisons. Finally we bring supply and demand together to partition wealth space into activity choice and credit market outcomes.

Wealth and Credit Supply

Intuition suggests that if anyone is quantity rationed in the formal sector, it will be the relatively poor who have insufficient wealth to post as collateral. This result has been established in the theoretical literature by various authors including Stiglitz and Weiss (1981), Carter (1988), and Bester (1985) and also obtains with our model. The logic of wealth biased quantity rationing in our model is as follows. Let W^* denote the wealth level such that all three constraints simultaneously bind. In figure 1, this would correspond to the horizontal limited liability constraint passing through point C so that a single contract $(R_g^*, -W^*)$ requiring her full wealth as collateral is available. If this agent's wealth is increased by \$1 it is easy to see that she will still have at least one contract available. In particular, the contract $(R_g^*, -W^* - 1)$ is incentive compatible since it holds constant consumption in the bad state while raising consumption in the good state by \$1, thereby increasing the borrower's incentive to work hard. This contract also satisfies the lender's participation constraint as it yields strictly positive expected profits. Thus any agent with wealth at least as large as W^* will have a contract available. A symmetric argument shows that agents with wealth less than W^* will have no contracts available so that, if anyone is quantity rationed, it will be the relatively poor.

As discussed above, monitoring allows informal lenders to offer loans with lower collateral than the formal sector. Thus agents with marginally less wealth than W^* will have access to an informal loan. We make the further assumption that an informal contract is available for all agents.[14]

Wealth and Credit Demand

The discussion above established the choices available to agents. All agents have the same reservation option. Relatively poor agents ($W < W^*$) choose between the reservation option and informal finance, while relatively wealthy agents ($W \geq W^*$) have the additional option of financing production with a formal loan. Examining the three pair-wise comparisons between activities will allow us to map activity choice over the wealth spectrum. For each comparison, we provide sufficient conditions for either the relatively wealthy or the relatively poor to prefer the riskier activity.

Reservation Activity versus Farming with Formal Loan

Who prefers high return but risky farming to the reservation activity? Assume that agents exhibit decreasing absolute risk aversion (DARA). Intuition suggests that the wealthy would bear the risk of farming while the poor would retreat to the certain reservation activity. This intuition, however, fails to consider that contract terms change with borrower wealth. In fact, the contracts available to wealthier agents are more risky than those available to poorer agents. Concavity of the utility function implies that wealthier agents are less sensitive to a given difference in consumption, and thus in contractual returns, across states. To provide sufficient incentives for the wealthier agent to work hard, the lender must increase contractual risk.

What is the net result of these opposing "risk aversion" and "incentive" effects of wealth? Ultimately, the relative size of these effects depends on the nature of the agent's preferences. Several papers in the literature on wealth effects in principal-agent models develop sufficient conditions for the dominance of one effect (Newman 1995; Mookherjee 1997; Thiele and Wambach 1999). Boucher, Carter and Guirkinger (2005) analyze this question with a single loan sector equivalent to our formal sector and develop necessary and sufficient conditions on

preferences to determine the direction of the wealth bias of risk rationing in the absence of monitoring. These conditions relate to higher order curvature of the agent's utility function. Specifically, if the agent's absolute prudence, P, is at least three times as large as absolute risk aversion, A, then the relatively poor will be risk rationed.[15] Conversely, if $P<3A$ then the relatively rich will be risk rationed. Without additional assumptions about $u(;)$, the relationship between P and A depends on the value of consumption at which these functions are evaluated. A useful specialization is the class of constant relative risk averse preferences (CRRA) because it implies that P/A is constant. In the remainder of the paper, we will restrict attention to this class of preferences.

Reservation activity versus farming with an informal loan

Next we take up the comparison between farming with an informal contract and the reservation activity. In the informal sector, monitoring allows the agent to trade risk against expected income. This additional contractual flexibility may reduce the incidence of risk rationing in the informal sector, but it need not eliminate it. We are then left with the question of who (i.e., the relatively wealthy or poor) is risk rationed in the informal sector?

Proposition 1. (***Wealth biased informal risk rationing***.) *Let $CE^I(W,m)$ denote the certainty equivalent associated with the optimal contract at the level of monitoring m for an agent with wealth W in the informal sector. Define $m^*(W)$ as the optimal level of monitoring in the informal sector for an agent with wealth W. Let $\hat{W}_{IR}$ denote the wealth level of the agent who is indifferent between financing the risky investment with her optimal informal contract versus the certain reservation activity so that: $u(\hat{W}_{IR} + CE(\hat{W}_{IR}, m^*(\hat{W}_{IR}))) = u(\hat{W}_{IR} + \varpi)$.*

Then: $P>(<)3A \rightarrow \frac{\partial CE^I}{\partial W} > (<)0$ so that any agent with wealth greater than (less than) $\hat{W}_{IR}$ will strictly prefer the risky investment with their optimal informal contract while agents with wealth less than (greater than) $\hat{W}_{IR}$ prefer the reservation activity.[16]

Note that the same condition on agent preferences that determines the direction of the wealth bias of risk rationing in the formal sector holds in the informal sector. This may appear surprising in light of our previous discussion about the ability of the informal sector to alleviate risk rationing. It is true that, for a given wealth level, the ability to monitor provides greater contractual flexibility and thus raises the maximum expected utility attainable by the borrower. Monitoring does not, however, affect whether the maximum attainable expected utility increases or decreases in agent wealth. This result is due to the separability of the agent's utility in monitoring and wealth. The same offsetting "incentive" and "risk aversion" effects described in the formal sector are at play in the informal sector and are independent of the level of monitoring.

Until now we have focused on the agent's comparison between a loan in each sector and the reservation activity. The final piece of the analysis, which will permit us to map sectoral and activity choice in wealth space, is to compare the relative attractiveness of the optimal formal versus informal contracts.

Farming with Formal versus Informal Loan

We have seen that if $P > 3A$, the relatively poor prefer the certain reservation activity to the risky contracts of either sector. Intuition would suggest that the relatively poor would then prefer the less risky informal contract to the more profitable formal contract. However, as shown by Rothschild and Stiglitz (1971) and Ross (1981), in the expected utility framework the ranking of preferences over two risky prospects is non-trivial and intuitions derived from the concept of absolute risk aversion need not hold. The following proposition shows that this intuition indeed

holds, namely the relatively poor prefer the less risky informal contract to the formal contract when $P > 3A$.

Proposition 2. (*Sectoral choice*.) *Let $\hat{W}_{FI}$ denote the wealth level of the agent who is indifferent between farming with her optimal informal contract and farming with her optimal formal contract so that: $u(\hat{W}_{FI} + CE^{I}(\hat{W}_{FI}, m^{*}(\hat{W}_{FI}))) = u(\hat{W}_{FI} + CE^{F}(\hat{W}_{FI}))$. Then if P>(<)3A any agent with wealth greater than (less than) $\hat{W}_{FI}$ will strictly prefer the formal contract while agents with wealth less than (greater than) $\hat{W}_{FI}$ prefer the informal contract.*[17]

We have now described the impact of wealth on each of the three pair-wise activity rankings and thus will enable a complete mapping of activity choices over the wealth spectrum. That is the task to which we now turn.

Mapping Activity and Sectoral Choice in Wealth Space

In this final step, we bring together the supply-side results that described which agents have access to contracts in each sector with the demand-side results that described the impact of wealth on the preference ranking of available activities. The mapping of agent wealth into activity and sectoral choice will depend upon two key relationships derived from the model's underlying parameters. The first is the direction of the sufficient condition regarding agents' preferences. As shown above, if $P > 3A$, the willingness to accept the (endogenously) greater risk associated with higher expected return contracts is increasing in agent wealth. The second is the ordering of the three threshold wealth levels, $\hat{W}_{FR}$, $\hat{W}_{IR}$, and $\hat{W}_{FI}$, and the minimum collateral requirement in the formal sector, W^{*}. While it would appear that there are an unwieldy number of potential orderings to consider, we are able to rule out many of them. Here we will only consider outcomes under the case $P > 3A$. A symmetric analysis obtains when $P < 3A$.

Propositions 1 and 2 establish the relative magnitudes of the slopes of the agent's three value functions at wealth levels such that two value functions cross. In particular, under $P > 3A$,

the value function of the relatively riskier activity is steeper at a crossing point. This result, combined with the uniqueness of the three crossing points implies only two possible orderings of the three threshold wealth levels: $\hat{W}_{FI} > \hat{W}_{FR} > \hat{W}_{IR}$ and $\hat{W}_{IR} > \hat{W}_{FR} > \hat{W}_{FI}$.[18]

Figure 4 depicts the three value functions when the first ordering holds.[19] Which of the two orderings obtains depends upon the relative attractiveness of the informal sector. Either an increase in the opportunity cost of funds in the informal sector or a decrease in the efficiency of monitoring (i.e. a reduction in β) would lead to a downward shift of the informal sector value function while leaving unchanged the other two value functions. If the downward shift is sufficiently large the second ordering would obtain.

Figure 4 shows that if the informal sector did not exist, no agent poorer than $\hat{W}_{FR}$ would farm. Even with the informal sector, the poorest agents ($W < \hat{W}_{IR}$) do not farm because the available informal contracts, although raising the agent's expected income, are too risky. Slightly wealthier agents ($\hat{W}_{IR} < W < W^*$) accept the risk of their informal contract and undertake farming. For this group, the informal sector plays the role of recipient of "spillover demand" since these agents are shut out of the formal sector for lack of collateral wealth. For agents in the next portion of the wealth spectrum ($W^* < W < \hat{W}_{FR}$), the informal sector relaxes formal sector risk rationing. Although a more profitable formal contract is available to them, they prefer the less risky, monitored loan of the informal sector. Agents with wealth greater than $\hat{W}_{FR}$ would farm even if the informal sector did not exist. The wealthiest agents ($W > \hat{W}_{FI}$) are willing to bear the risk of the formal sector contract. The slightly less wealthy ($\hat{W}_{FR} < W < \hat{W}_{FI}$) instead prefer an informal loan.

The informal sector thus plays a critical role for agents in the intermediate range of the wealth spectrum ($\hat{W}_{IR} < W < \hat{W}_{FR}$) as it affects their activity choice and allows them to undertake the socially desirable activity. For a given ordering of the threshold wealth levels, the overall impact of the informal sector on the economy would thus depend on the distribution of wealth..

Extension to Multiple Farm Sizes

In the previous section we saw that the assumption that $P > 3A$ results in an intuitive mapping of wealth into activity and sectoral choice in which the beneficiaries of the insurance provided by the informal sector are the relatively poor. This assumption, however, is restrictive. Specifically, under CRRA preferences, $P > 3A$ corresponds to a coefficient of relative risk aversion, ρ, smaller than 0.5. Several empirical studies, such as those cited in Gollier (2002) suggest that plausible ranges of ρ are between one and four. In this section we extend the model by allowing heterogeneity not only in financial wealth but also in the agent's endowment of productive wealth, i.e., their farm size. This extension yields an intuitive partitioning of the two-dimensional wealth space when the restrictive preference assumption ($P>3A$) is relaxed.

Why would financial and land wealth have different impacts? The intuition is as follows. For a given farm size, the difference in expected consumption under farming with a loan contract versus the reservation activity is independent of the agent's financial wealth. Lenders, however, must shift greater contractual risk towards the borrower in order to induce financially wealthier agents to exert high effort. Under $P < 3A$ (i.e. preferences consistent with empirical evidence), above a threshold level of financial wealth, farming becomes too risky to justify the gain in expected income from farming so that the financially wealthiest agents withdraw to the reservation activity. In contrast, as the agent's land wealth increases, the expected consumption

foregone by choosing the reservation activity increases, so that agents with a greater land endowment are more willing to bear the risk of the contract and to farm.

A straightforward modification of the model captures this intuition. An agent is now endowed with financial wealth, *W,* and land, *T*. The agent chooses between farming on her entire land endowment or renting it out at fixed rental rate γ. The required farm investment is now TK and gross revenues are TX_g and TX_b in the good and bad states. As before, the agent needs outside financing to farm. The optimal formal sector contract now specifies the borrower's return per unit land in each state and is the solution to the following program:

$$(12) \quad V_F(W,T) \equiv \underset{R_j^F}{Max}\, EU(R_j^F, H, 0)$$

subject to:

$$(13) \quad [u(W + TR_g^F) - u(W + TR_b^F)](p^H - p^L) \geq B(0)$$

$$(14) \quad p^H(X_g - R_g^F) + (1 - p^H)(X_b - R_b^F) - r^F K \geq 0$$

$$(15) \quad TR_j^F > -W \quad j = g, b$$

The formal lender's participation constraint is unchanged since returns and investment per unit of land have not changed. The incentive compatibility and limited liability constraints, however, are modified to account for *T*.[20] The optimization program in the informal sector is modified in a similar fashion.

In this model extension, the role of financial wealth in sectoral and activity choice is unchanged. Namely, under CRRA, $\rho < 0.5$ is necessary and sufficient such that agents with low financial wealth are more likely to prefer the relatively safe activity. A change in land wealth, however, may yield a different outcome. Holding *W* constant, $\rho < 0.5$ is sufficient but no longer necessary for the land poor to prefer the relatively safe activity. While an analytic expression for the maximum value of ρ such that this intuitive result holds does not exist, we know that it is

larger than 0.5 and is increasing in the difference between the land rental rate and the expected per-hectare return from farming.[21]

Figure 5 maps the activity and sectoral choices in *(W,T)* space that result from a numerical computation of the model.[22] For the computation, a CRRA utility function with $\rho=0.75$ was chosen.[23] Other parameters were chosen so that quantity rationing does not occur. This allows us to focus on the role of financial wealth and farm size on the choice between available contracts and activities.

Consider the agent at point *N* who is indifferent between farming with a formal and an informal loan. The vertical ray shows the counter-intuitive role of financial wealth for a farm size of 2.5. Financially poorer agents than *N* farm with a formal loan; those with slightly greater financial wealth farm with an informal loan; while the financially wealthiest retreat to the reservation activity. Movements along the horizontal ray show the opposite and more intuitive result. Holding financial wealth constant at 900, agents with a larger land endowment than *N* farm with a formal loan; those with smaller land endowment prefer an informal loan; while the land-poorest rent their land out. The indifference frontiers, $\hat{W}_{IR}(T)$ and $\hat{W}_{FI}(T)$ divide wealth space into activity choice and are upward sloping. The magnitude of their slopes, in turn, depends on underlying model parameters. Ultimately, the importance of the informal sector will depend on both the shape of these frontiers and the empirical distribution of wealth. If, as we expect, there is a positive correlation between the two types of wealth so that farmers are grouped along the diagonal ray in Figure 5, then the informal sector would be chosen by farmers of intermediate wealth while the richest would seek out the formal sector.

This analysis shows that heterogeneous asset types have different impacts on incentives and thus the nature of contracts available. Therefore both heterogeneity of asset types controlled

by an individual as well as heterogeneity of total wealth across individuals are important in understanding household participation in credit markets.

Conclusion

In this paper, we have developed a model that suggests a re-evaluation of the role of the informal loan sector in rural areas of developing countries. The informational advantage of informal lenders is portrayed as their ability to monitor borrowers. Monitoring, by limiting the private benefit the borrower perceives by shirking, reduces the incentive problem and allows for contracts with lower collateral. This enables informal lenders to serve two types of clients: 1) Those who cannot post the collateral required by the formal sector; and 2) Those who are able but do not want to post collateral. These borrowers are willing to accept a lower expected income in exchange for lower contractual risk. The model is thus consistent with the conventional view of the informal sector as recipient of spillover demand from the formal sector. It also suggests an additional role of the informal sector, namely as provider of partial insurance. Previous models, by assuming risk neutrality of borrowers, do not permit this role because they rule out contractual risk as a determinant of sectoral choice. Neglecting the impact of risk-sharing rules of credit contracts is particularly problematic in rural areas of developing countries where risks are high and insurance markets are thin.

While the informal sector always plays the first role (i.e., relaxing quantity rationing in the formal sector) for the relatively poor, for whom the informal sector relaxes risk rationing in the formal sector depends upon the nature of agents' preferences. Because of multiple and offsetting effects of agent wealth, the less risky informal sector may be chosen by either the relatively wealthy or the relatively poor. The propositions of section four provide sufficient

conditions for either result. The importance of the informal sector is ultimately an empirical question and will depend both upon the level of development of and the nature of contracts available in the formal credit sector and the distribution of wealth in the rural economy.

The potential insurance role highlighted in this paper offers an additional explanation of the often observed co-existence of a vibrant informal sector alongside a formal loan sector. It also suggests that credit market policies that are geared solely at relaxing supply side constraints may have limited impact on rural households' participation in the formal sector. For example, a land titling program, by increasing a household's capacity to provide collateral, may be necessary to guarantee access to the formal sector. A title is not sufficient, however, as households may prefer to remain in the informal sector or not participate in the credit market at all for fear of losing collateral. As the non-collateral terms of formal loan contracts tend to dominate those of informal loans, this suggests that policies that facilitate rural households' capacity to manage risk are important to increase their willingness to participate in the formal sector.

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Tables and Figures

Table 1. A Comparison of Contract Terms Across Loan Sectors

Contract Term	Peru		Honduras		Nicaragua	
Loan Size ($US)	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.
Formal	1,560*	2,000	2,570*	5,670	5,860*	9,200
Informal	350	770	770	2,760	580	1,460
Semi-formal	670*	840	1,300	3,440	640	2,470
Maturity (Months)						
Formal	12.4*	29	12.3*	9.2	15.1*	13.0
Informal	5.3	3.6	6.7	5.7	10.0	20.7
Semi-formal	35*	43.6	8.1	8.1	8.8	8.0
Annual Interest Rate (%)						
Formal	69*	47	27*	11	29*	22
Informal	117	53	65	70	43	38
Semi-formal	36*	28	71	104	27*	20
% requiring collateral						
Formal	58*	50	66*	47	86*	34
Informal	9	29	9	28	17	37
Semi-formal	16	37	14	34	28*	45

* Loan term significantly different (at 5%) from the same term in the informal sector

Table 2. Credit Market Participation and Household Wealth by Formal Sector Access

	Peru		Honduras		Nicaragua	
	%	*Wealth*[a]	%	*Wealth*	%	*Wealth*
Positive supply	**71%**	**15**	**65%**	**43**	**51%**	**23**
Formal loan	29%	17	27%	63	8%	59
Informal loan	17%	13	7%	20	6%	21
Both	6%	14	7%	44	0%	
Semi-Formal loan	4%	11	6%	38	16%	14
None	44%	15	53%	37	70%	22
	100%		100%		100%	
No supply	**29%**	**12**	**35%**	**13**	**49%**	**7**
Informal loan	28%	9	18%	7	8%	7
Semi-formal loan	5%	6	9%	13	14%	8
None	66%	13	74%	14	78%	7
	100%		100%		100%	

[a]Household wealth includes the value of farm, business and residential assets and is reported in thousands of $US.

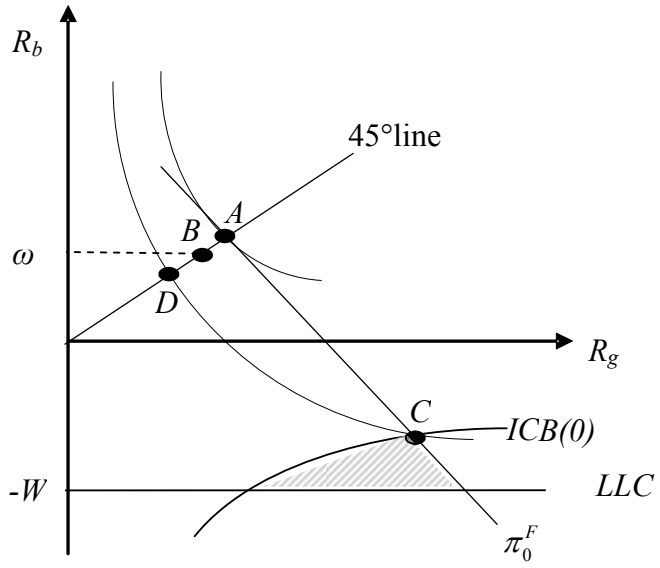

Figure 1. Formal Feasible Set and Optimal Contract

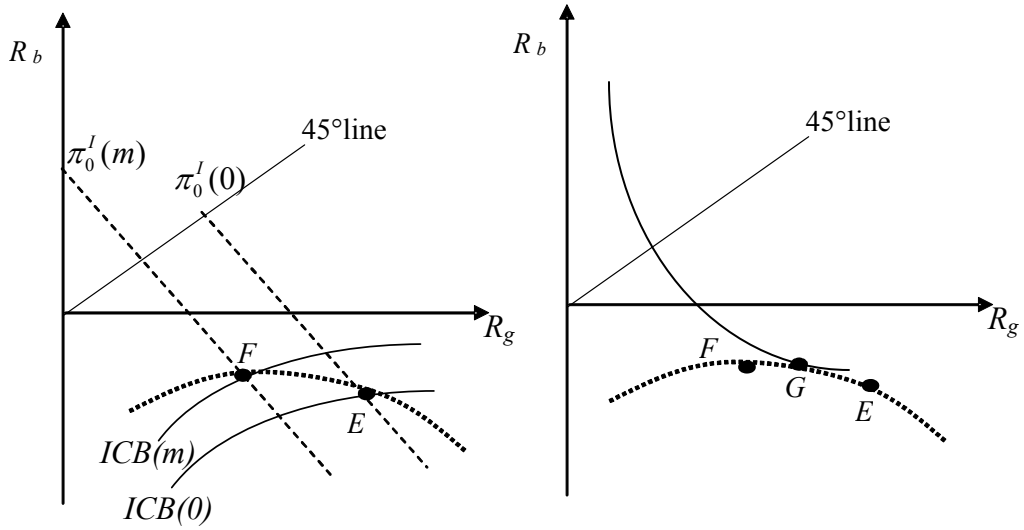

Figure 2. Informal Contract Set and Optimal Contract

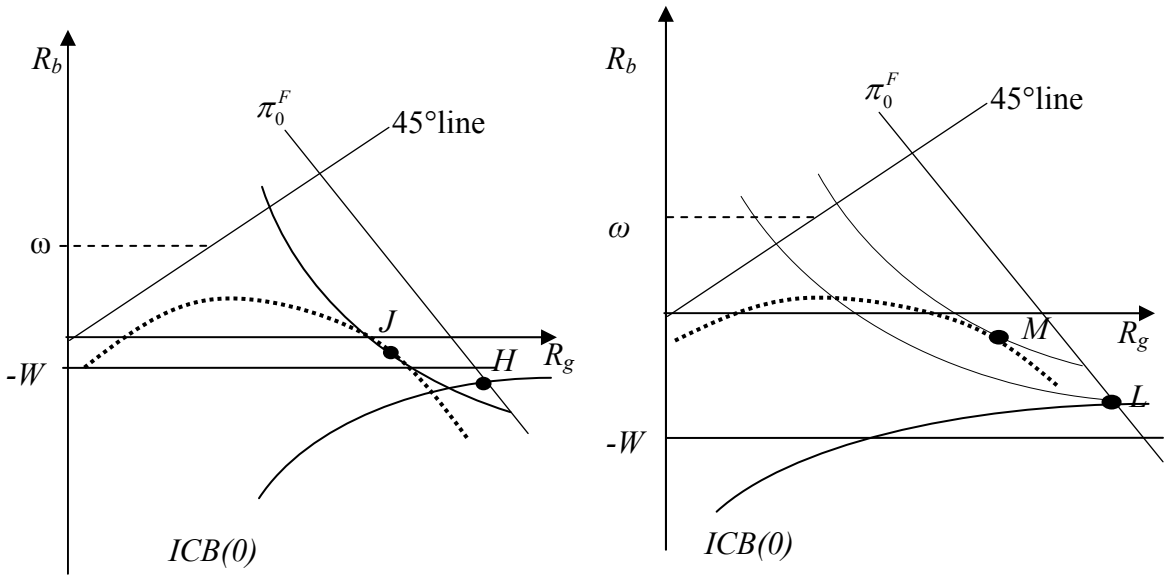

Figure 3. The Informal Sector Relaxes Quantity (Left Panel) and Risk Rationing (Right Panel)

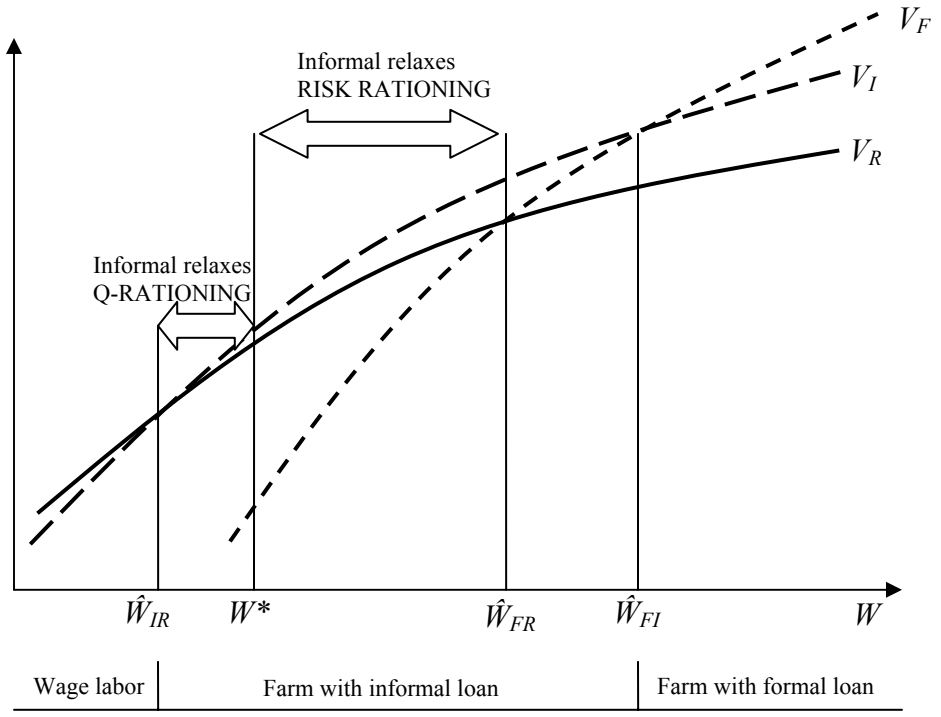

Figure 4. A Mapping of Wealth into Activity and Sectoral Choice ($P > 3A$)

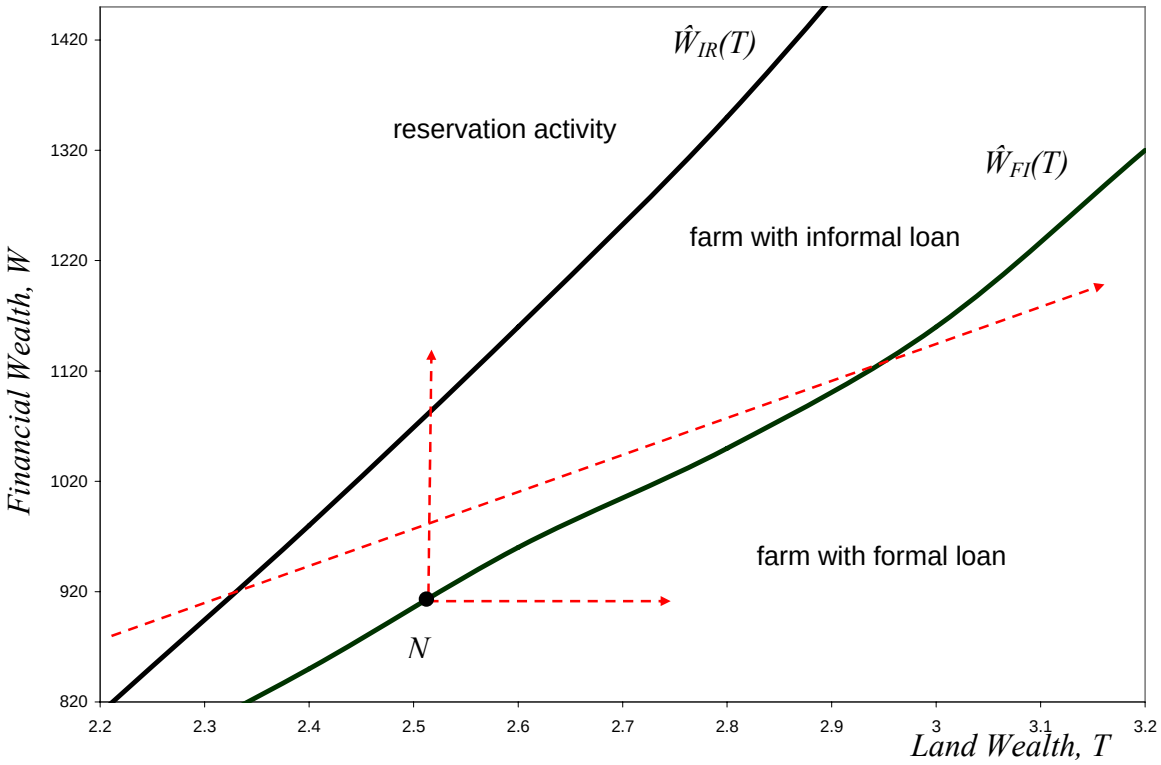

Figure 5. Activity Choice with $P < 3A$ and Two Types of Wealth

Footnotes

[1] Udry (1990) shows in the context of rural West Africa, that informal credit markets are relatively efficient at sharing idiosyncratic risk across borrower and lender within villages. Udry's emphasis, however, is different from ours in that he does not explicitly model asymmetric information in loan contracts nor does he consider sectoral choice since a formal loan sector does not exist in his empirical context.

[2] See Boucher, Barham and Carter (2005) for a discussion of the Honduras and Nicaragua samples. A description of the Peru sample is provided in Boucher (2000).

[3] Loans from family and friends that charged zero interest and were not inter-linked are excluded from Table 1. As pointed out by a referee, these loans are likely to be quasi-credit transactions characteristic of informal risk sharing networks described, for example, by Thomas and Worrall (2002) instead of the more commercial credit relationships that are the concern of this paper.

[4] Loans that charged zero explicit interest rate and were inter-linked with a transaction in an input or output market are excluded from the interest rate calculation because the data sets do not allow us to quantify the effective interest cost of these loans.

[5] As pointed by a referee, this need not hold if informal loan terms are systematically better for households that have access to a formal loan. This is not the case in our data. Only in the case of informal loan size in the Nicaragua sample there is a significant difference across formal sector supply category.

[6] The preference for informal loans may also be explained by a story of risk neutrality cum transaction costs. The Honduras and Nicaragua data do not provide detailed information about transaction costs. In the case of Peru the transaction costs associated with time and

documentation account for less than half of the interest rate differential across the formal and informal sector.

[7] The alternative formulation of the problem where farmers invest *W* in the project and borrow (*K-W)* yields the same results in terms of activity and sectoral choices.

[8] We assume that effort is not a choice variable in the reservation activity which requires the agent to exert high effort.

[9] Under a full collateral contract, i.e., $R_b = -W$, the borrower earns zero income. If the borrower's utility under zero income tended towards negative infinity, then any full collateral contract would provide sufficient punishment to the borrower so that she chooses high effort. Quantity rationing would never obtain.

[10] This specification is consistent with two alternative interpretations of monitoring. On one hand, the more visits a lender makes to the borrower's farm, the greater is the likelihood that he will catch a shirking borrower and be able to impose a fixed punishment. Alternatively, additional visits may provide the lender with greater "evidence" of shirking and thus allow him to impose a larger punishment.

[11] Note that defining the borrower returns R_b^F and R_g^F is equivalent to defining an interest rate, *i*, and level of collateral, *C* as follows: $R_g^F = X_g - (1+i)K$ and $R_b^F = X_b - C$.

[12] Inspection of equations (5) and (6) reveals that the slope of the *ICB(0)* and π_0^F are respectively $u'(W + R_g)/u'(W + R_b) > 0$ and $-p^H/(1-p^H) < 0$, so that the intersection of these curves is unique.

[13] The following three conditions are sufficient for the existence of informal contracts that require less collateral than the formal sector and are expected income enhancing relative to the

reservation activity: 1) $r^I K \leq \frac{EX_j - \varpi + r^F K}{2}$; 2) $u'(0) < \frac{p^H \beta}{2(p^H - p^L)}$; and 3) $\rho < 1$, where ρ is the coefficient of relative risk aversion. A proof is available from the authors.

[14] The model allows for quantity rationing in the informal sector as well as the formal sector. In that case, the poorest agents would not have access to either sector. As the focus of our analysis is sectoral choice, no additional insights are gained by considering this possibility.

[15] The coefficients of absolute risk aversion and prudence are defined as: $A = -\frac{u''}{u'}$, $P = -\frac{u'''}{u''}$. Prudence measures the degree of curvature of marginal utility and thus affects how absolute risk aversion changes with wealth. To see this, note that $A' = A(A - P)$. The larger is prudence relative to absolute risk aversion, the faster risk aversion decreases with wealth and thus the stronger is the "risk aversion" effect. The size of the "incentive effect", in contrast, depends on how quickly the marginal utility of income decreases with wealth which, in turn, depends only upon the size of absolute risk aversion.

[16] A proof of proposition 1 is provided in the appendix.

[17] A proof of proposition 2 is provided in the appendix.

[18] The crossing points are unique since V_F, V_I and V_R are all strictly increasing in wealth, and the direction of the crossing is unambiguous at each crossing point.

[19] Under the alternative ordering, either the reservation activity or farming with a formal loan dominates farming with an informal loan for all wealth levels. We therefore focus of the more interesting first ordering which admits informal loans as an equilibrium outcome.

[20] For simplicity, we again assume that the reservation activity requires high effort. Relaxing this assumption complicates unnecessarily the analysis and does not change the main results.

21 This result is established and discussed in the appendix.

22 We assume there are no land sales markets, therefore heterogeneity in farm size results from endowment heterogeneity.

23 We use the following functional forms for utility and the private benefit of low effort: $u(C)=4C^{0.25}$ and $B(m)=2-0.1m$. The values of the other model parameters are: $p^H=0.7$, $p^L=0.2$, $r^F=0.25$, $r^I=0.35$, $K=15$, $X^H=70$ and $\gamma=35$.